2. PREVIOUS STUDIES AND CURRENT PROGRAMS

2.1 General

The work on this feasibility study has benefited substantially from several previous studies, which have laid the groundwork to identify new water sources and transmission improvements that will be required through the year 2030. There are also several on-going studies and programs that impact this study. These are described below.

2.2 Previous Studies

Two studies funded by the French government have provided detailed technical information on the existing water supply system, and required improvements in rehabilitation, re-structuring and expansion to meet water demands in 2025. The consulting firm SOGREAH studied the governorates of Irbid, Jerash and Ajloun in a study entitled *Hydraulic Analysis of the Water Systems in Irbid Governorate,* which is documented in 12 volumes plus a set of drawings in AutoCAD. SAFEGE conducted a similar study for the remaining governorate, entitled *Hydraulic Analysis of the Water Systems in the Mafraq Governorate* documented as 7 reports in 21 volumes. Both studies were completed in 1998, and both covered topics relevant to this study:

- Mapping and inventory of the pipes in the existing distribution systems;
- Development of layout drawings and identification of required improvements at existing pump stations;
- Field studies on water rationing and on the causes of leakage and unaccounted-for water in the existing distribution systems;
- Forecasts of population and water demands to year 2025;
- Hydraulic network analysis to identify the future needs for new wells, pipelines, reservoirs, and pump stations;
- Development of programs for restructuring and rehabilitation of the local secondary networks; and
- Development of preliminary designs, drawings and maps (in AutoCAD) showing the existing facilities and the proposed pipelines and other facilities.

Subsequently, NGWA has transferred the data on existing pipelines mapped in the two French-funded studies from AutoCAD drawings into a GIS database. This GIS database in turn has been used in this feasibility study; the same pipe designations have been retained, to allow for a future comparison of the required sizes of future pipelines.

Previous studies on water supply sources, particularly those on groundwater resources, are described subsequently in Section 5 of this report. Engineering information on the major potential future sources has been derived from several sets of previous studies:

- For development of the Mukheiba Springs (located near the mouth of the Yarmouk River), the most detailed investigation has been made by IWACO, in a feasibility study funded by the European Union, entitled the *Conveyance System Project* and printed in 6 volumes, that was completed in 2000. This study included an assessment of the available yield, raw water quality, treatment requirements, comparison of pipe routing alternatives, and a preliminary design of the pump stations and pipelines required to carry the flows from the Mukheiba Wells to Irbid.

- For development of the Al Wehdeh Dam on the Yarmouk River, a series of 9 reports dated 1988 through 2002 were provided by JVA; in addition, AutoCAD drawings of the original design, and revisions made during the current construction of the dam, have been provided by JVA and their consultant MWH. These have been used in the current study to identify the means of obtaining water supply for Irbid, through the planned power penstock and outlet from the dam.

- For re-allocation of water to the northern governorates (either from irrigation or Mafraq wells that supply the Amman-Zarqa water systems), attention in our study was given initially to the JICA-funded study by Yachiyo Engineering Co., entitled *The Study on Water Resources Management in the Hashemite Kingdom of Jordan,* which was completed in 2001. However, the recently-announced GTZ-funded National Water Master Plan is considered to provide a more detailed and more current assessment of water demands, water allocations and water transfers. The GTZ plan is discussed below as a current program.

2.3 Current Programs

Three on-going programs within WAJ and NGWA have required close coordination with this study. As noted previously, this Feasibility Study has been extended to 28 February 2005 to allow, as much as possible, coordination of findings, data used and assumptions made with the WLRP and NWMP projects described below.

- The foreign-assistance branch of the German government, GTZ, has funded the OMS (Operations Management Support) project, which has encompassed the development of a GIS (mapping and database system) for the NGWA service area. This has progressed to the point where NGWA has mapped the location and metered use of each customer, and can display information on a variety of base maps at different scales, depending upon the level of detail required. Imports and exports of water, to and from the transmission system, and to and from other governorates, are also tracked based on an array of bulk flow meters at the flow-transfer locations. The use of the GIS system in this study is described in more detail in Section 3. In addition, the OMS project has conducted useful analyses on reduction of physical and administrative water losses, and on improvements to reduce power consumption at pump stations and wells.

- KfW, also under the German government, is funding the Water Loss Reduction Program (WLRP), which is conducting field studies and hydraulic analyses that will be used in rehabilitation, restructuring, and expansion of local distribution networks. Project implementation is expected to include such items as: selective replacement of service connections and tertiary distribution mains to reduce leakage; additional storage reservoirs and pressure zones to reduce operating pressures and allow rationing of water to district zones; and piping reinforcements sufficient to carry the peak flows forecast for the year 2025. MWH are the lead consultants on the WLRP. The engineering work has been divided between this study (NGWTS) and WLRP as follows: NGWTS is doing the hydraulic modeling and engineering on the transmission system, which extends from the major water sources up to the local distribution reservoirs; WLRP is doing the hydraulic modeling of the local distribution networks that are supplied from these distribution reservoirs. Currently, the WLRP expects that there will be about 101 local distribution reservoirs, compared to the existing 30 reservoirs. The WLRP hydraulic analyses and preliminary

conceptual design report were completed by 16 August 2004, and have been used on this study to carry out the hydraulic analyses and feasibility-level designs for the transmission system alternatives. The final proposed Transmission System in the NGWTS study was developed on the basis of the WLRP proposed local distribution reservoirs proposed in the WLRP Final Conceptual Report. Further details on coordination with WLRP are given in Section 7 of this report.

- MWI has formed a National Water Master Planning Directorate, which has undertaken the development of computer-based tools, maps and databases. These have now been applied to obtain preliminary estimates of water demands, available yields, water allocations and transfers over a planning period extending to 2020 (but easily extendable to 2040). The results obtained to date represent the initial version of the National Water Master Plan (NWMP). The methodology, findings and results of the work to date were presented at a seminar on 18-19 July 2004. CDM attended the seminar, and on 12 July CDM received preliminary data on the water allocations to the northern governorates. These results were subsequently updated and a revised set of allocations were provided to CDM by the Directorate first on 29 July 2004 and subsequently on 29 August 2004. As discussed subsequently in Section 4, a "modified Scenario 2" NWMP demand forecast has been adopted for use in this study.